

DISCUSSION ON
RHIC LATTICE

J. Claus

April 2, 1984

Brookhaven National Laboratory

RHIC Lattice

History: CBA 1 in 1, symmetric, $\beta_x^* = 40$, $\beta_y^* = 7.5 - 2$ m

CBA 2 in 1, anti-symmetric, $\beta_x^* = \beta_y^* = 7 - 2$ m

RHIC Feasibility Study

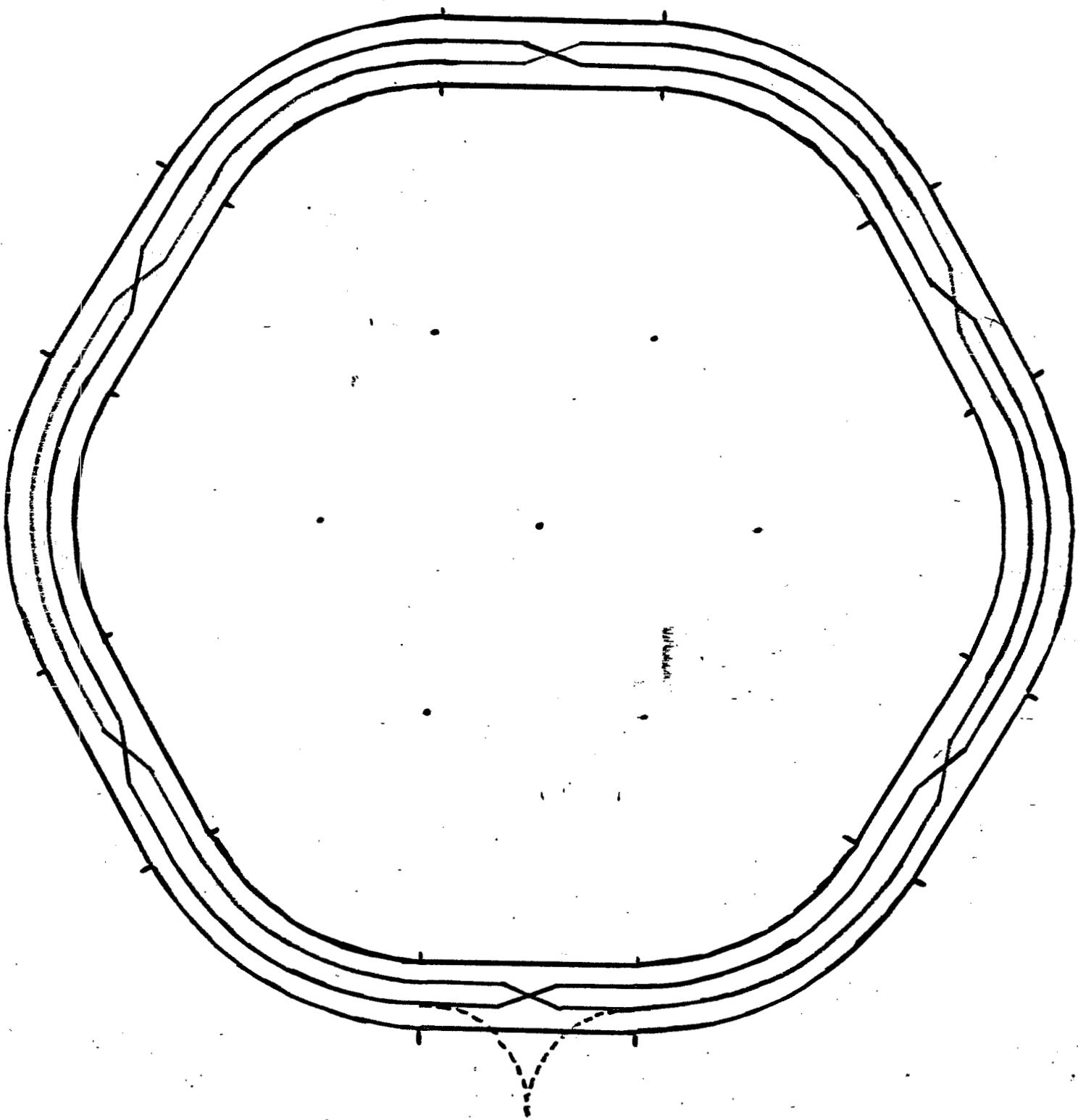
CBA 2 in 1, symmetric, missing magnets

RHIC 1, symmetric, $g \times 90$, $\beta_x^* = 40$, $\beta_y^* = 7.5$ m

RHIC 2, symmetric, 12×100 , $\beta_x^* = 17$, $\beta_y^* = 3$ m

RHIC 2 Parameters:

Circumference (m)	3883.845
Radius of Arcs (m)	381.2332
Distance between Rings (m)	0.15 - 0.18 - 0.24 - 0.30
Number of cells / arc	12
Half cell length (m)	14.811
Deflection angle/half cell ($\int B dl / B_p$ per arc dipole in rad)	38.85
$\int B' dl / B_p$ per arc quadrupole (m ⁻¹)	0.1065
Number of dipoles / ring	144 + 24 + 24
Number of quadrupoles / ring	234
Distance from crossing point to nearest magnet (m)	10.
D_x/D_y	31.6 / 31.6
$\Delta\psi_x / \Delta\psi_y$ per arc cell (units of $\frac{2\pi}{360}$ rad)	0.2722 / 0.2722
$\hat{\beta}_x / \hat{\beta}_y$ in arcs (m)	51.58 / 7.46
$\hat{\beta}_y / \hat{\beta}_x$ in arcs (m)	51.58 / 7.46
\hat{x}_p / \hat{y}_p in arcs (m)	1.385 / 0.640
$\Delta\psi_x / \Delta\psi_y$ per insertion (units of $\frac{2\pi}{360}$ rad)	2.0 / 2.0
$\beta_x^* / \beta_y^* / x_p^*$ (m)	17.7 / 3.0 / 0.0
$\hat{\beta}_x^* / \hat{\beta}_y^*$ (m)	267. / 667.



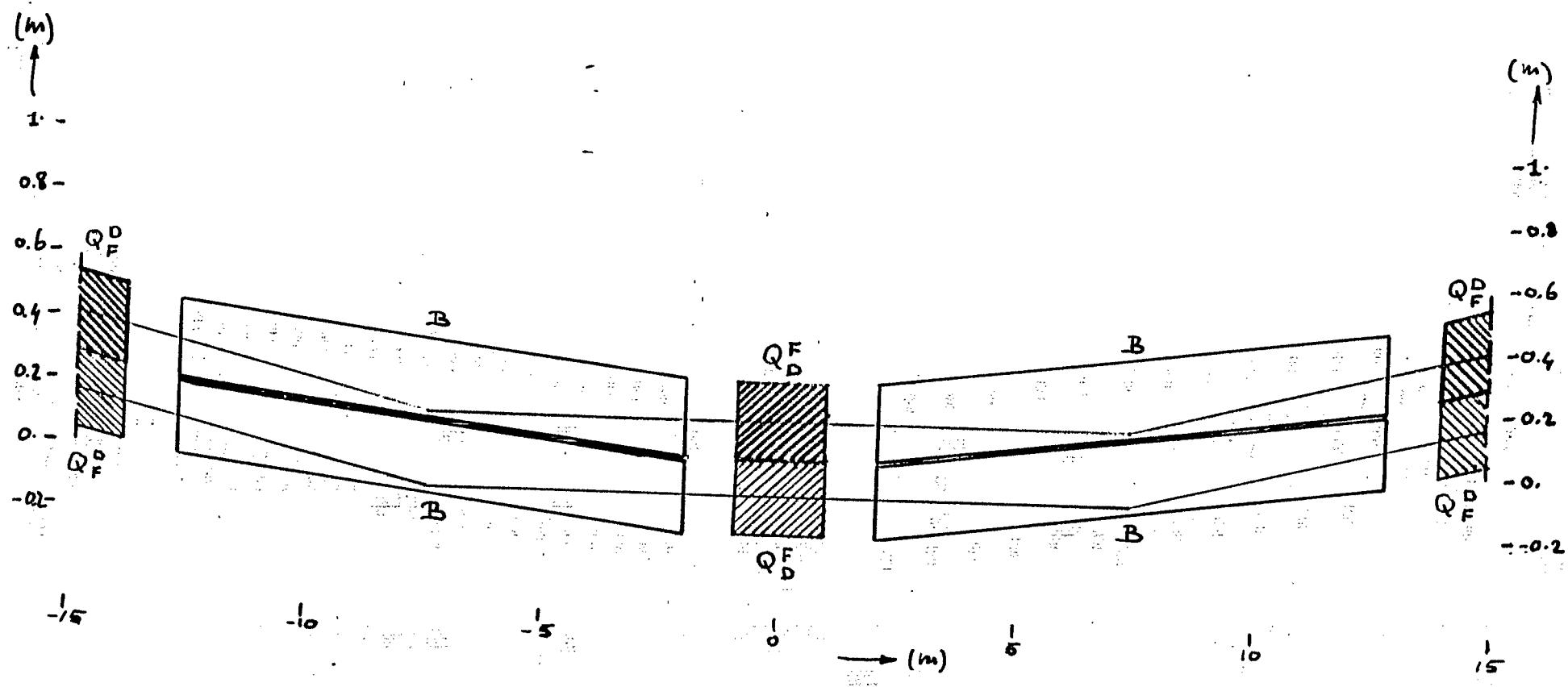
RHIC Regular Cell Pair

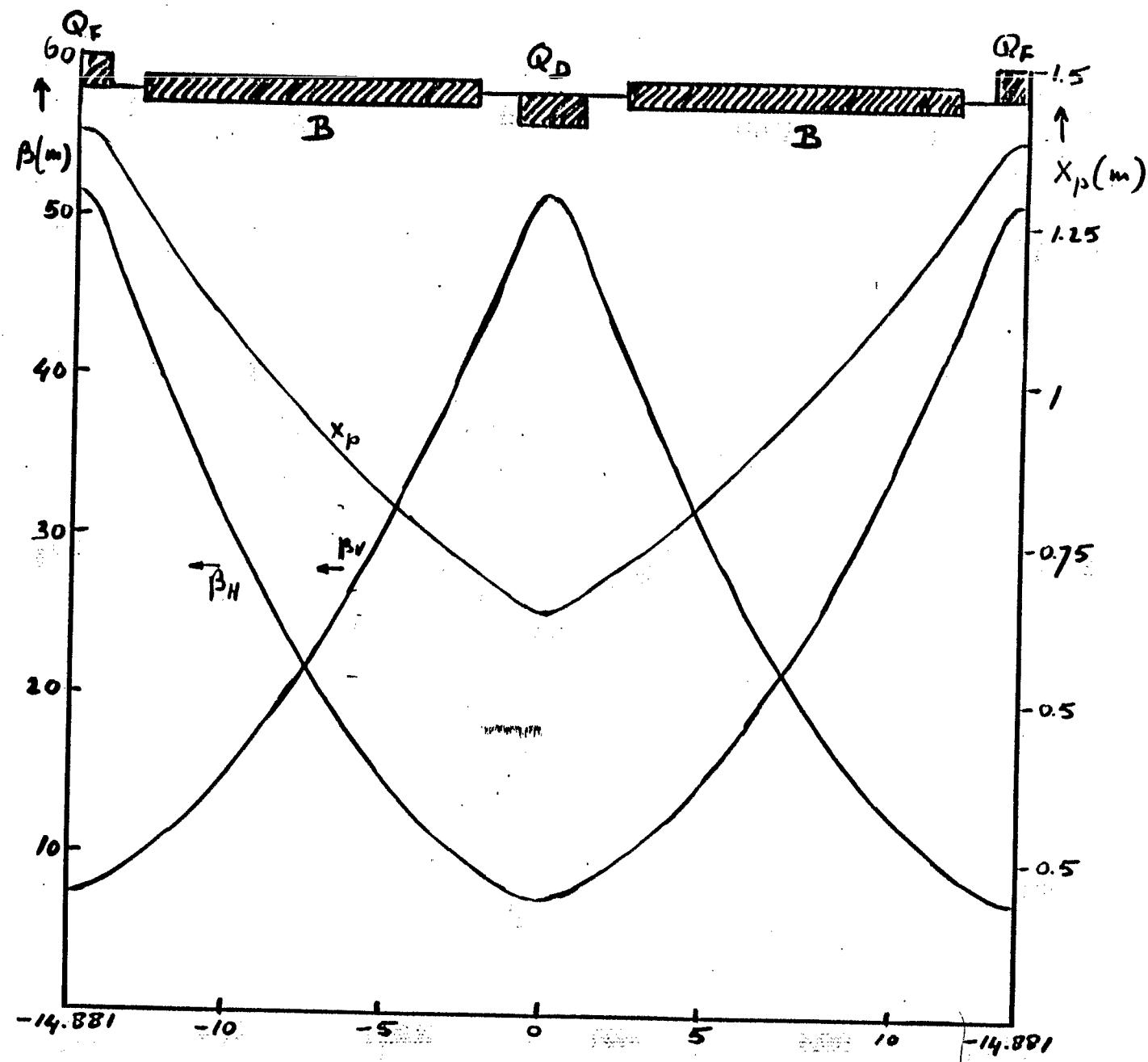
$$\Theta_H = \frac{\int B d\ell}{B_P} = 0.03885 \text{ rad}$$

$$\frac{\int B' d\ell}{B_P} = 0.1065 \text{ m}^{-1}$$

$$R_{av} = 381.25 \text{ m}$$

$$L_{HC} = 114.811 \text{ m}$$

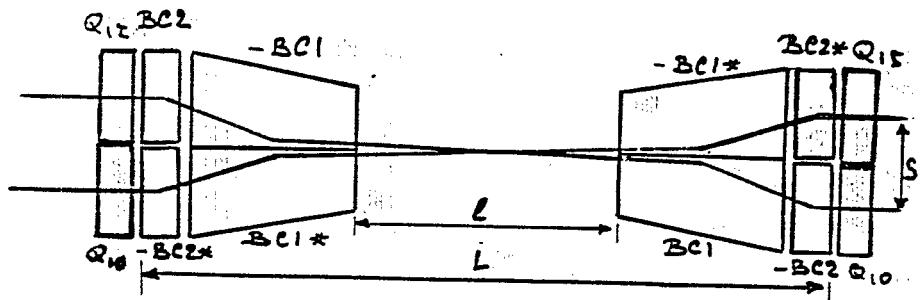




RHIC REGULAR ARC CELL (02/14/84 og. 48.54)

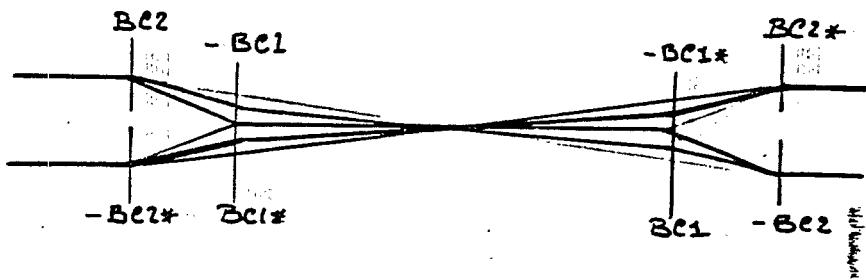
Crossing Point Regions

Present arrangement:



$$\begin{aligned} l &= 22 \text{ m} \\ \alpha &= 2 - 8.7, 10.8 \text{ mrad} \\ S &= 0.24 \text{ m}, 0.30 \text{ m} \\ L &= 58 \text{ m} \end{aligned}$$

stylize to:



$\pm BC_1, \pm BC_2, \pm BC_1^*, \pm BC_2^*$ are dipoles with parallel entrance and exit edges, \pm indicates polarity.

For operation with equal momenta (B_p values) in the two rings: $(-BC_1, BC_1^*)$ and $(BC_1, -BC_1^*)$ can each be a one aperture magnet, but a aperture must be large enough to accomodate the desired range of α .

Colinear beams: equal deflection angles in all magnets.
"Natural" crossing angle: no deflection in units BC_1 .

For operation with different momenta $(B_p)_1 / (B_p)_2 \leq 2.5$
 $|BC_2^1| \neq |BC_2^{1*}|$: colinear beams impossible.

In order to minimize α , maximize effective aperture:

Construct $(-\mathbf{B}_{\text{CI}}/\mathbf{B}_{\text{C1}*})$ and $(\mathbf{B}_{\text{C2}}/\mathbf{B}_{\text{C2}*})$ as two aperture septum magnets.

Septum must carry current (for unequal B_p 's) and be thin: low fields and therefore long magnets.
Present arrangement can be improved upon by sectionalizing these magnets into shorter units with increasing fields and septum thicknesses.

Optimization Problem: L should be minimized at fixed ℓ in order to maximize effective aperture elsewhere in the rings $\rightarrow \mathbf{B}_{\text{C1}}$ and \mathbf{B}_{C2} should be short and therefore strong

Ring design Problem: the crossing dipoles cause significant dispersion; anti-symmetric relative to the crossing point, a major perturbation in an otherwise symmetric lattice.

Present approach: try to live with it.

Consequences: severe loss of symmetry properties, effective aperture and flexibility.

Alternatives: a) introduce extra quad to remove dispersion. Promising results so far.
b) use anti-symmetric lattice, like CBA's anti-symmetric 2u1.

↑
(m)

R H E C Half Insertion (02/14/84 09:48:54)

Quad Strengths ($\frac{\int B_{\text{idle}}}{B_p}$, m⁻¹)

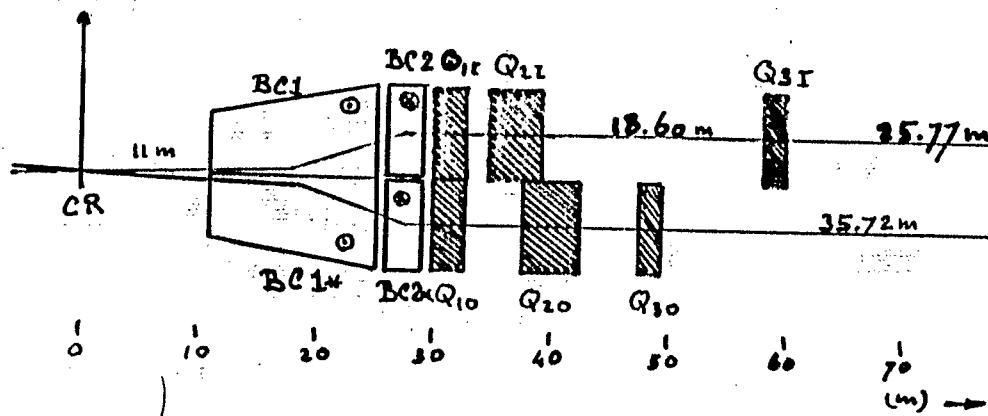
Q1	0.09070	0.09273
Q2	0.11593	0.11919
Q3	0.05906	0.04531
Q4	0.11367	0.12628
Q5	0.13379	0.10985
Q6	0.10440	0.09167
Q7	0.09040	0.12905
Q8/QF	0.08884	0.11272

2-

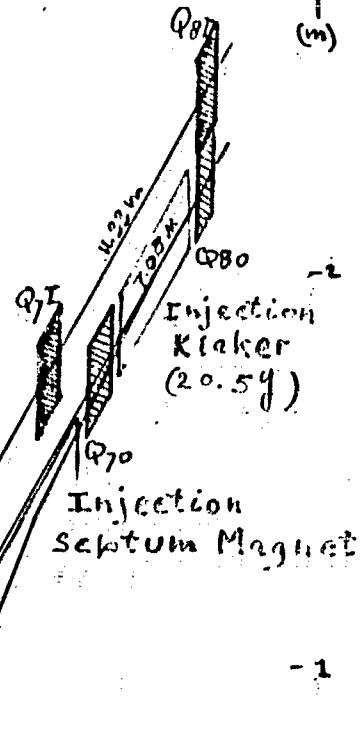
2-

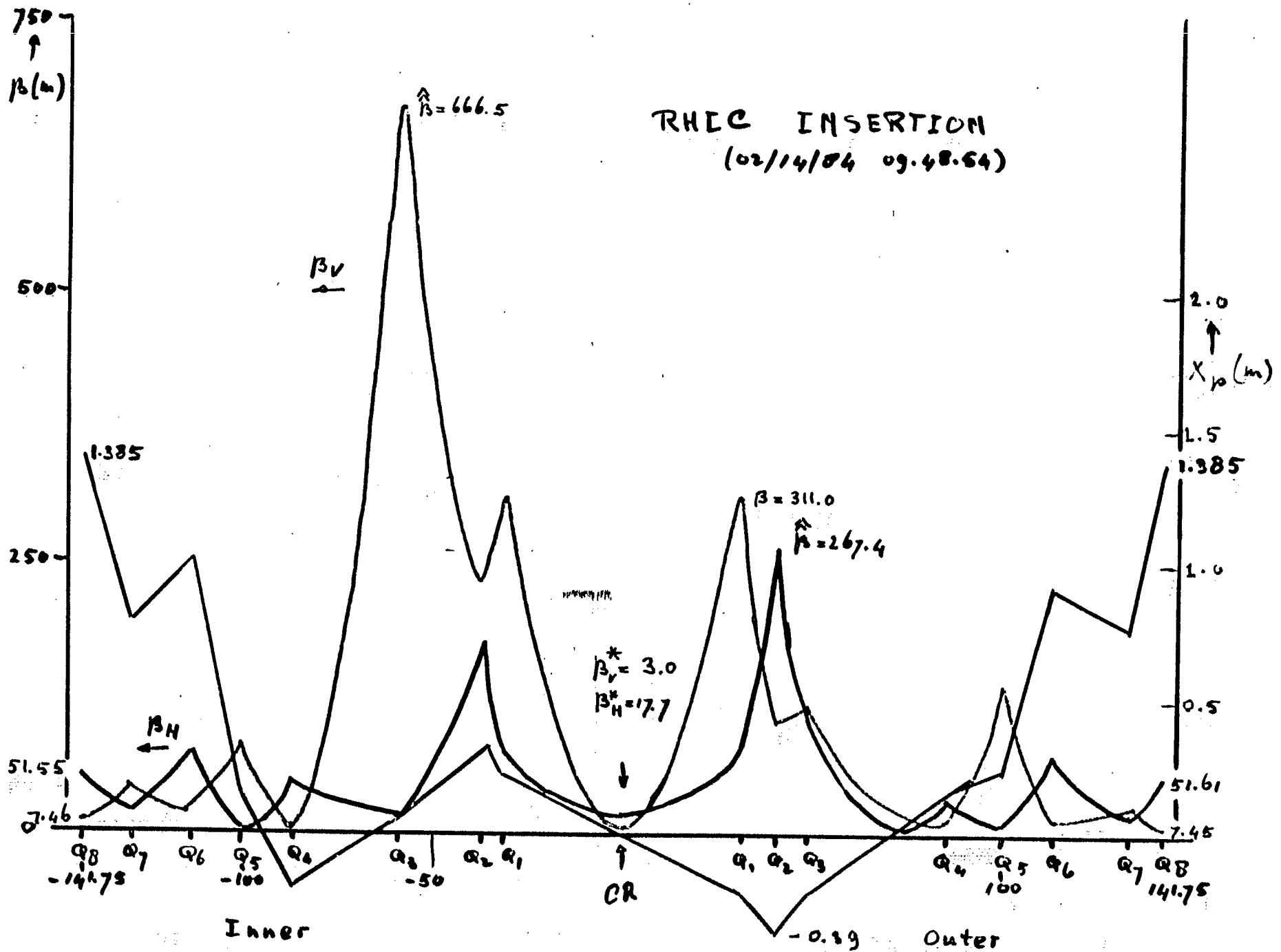
2-

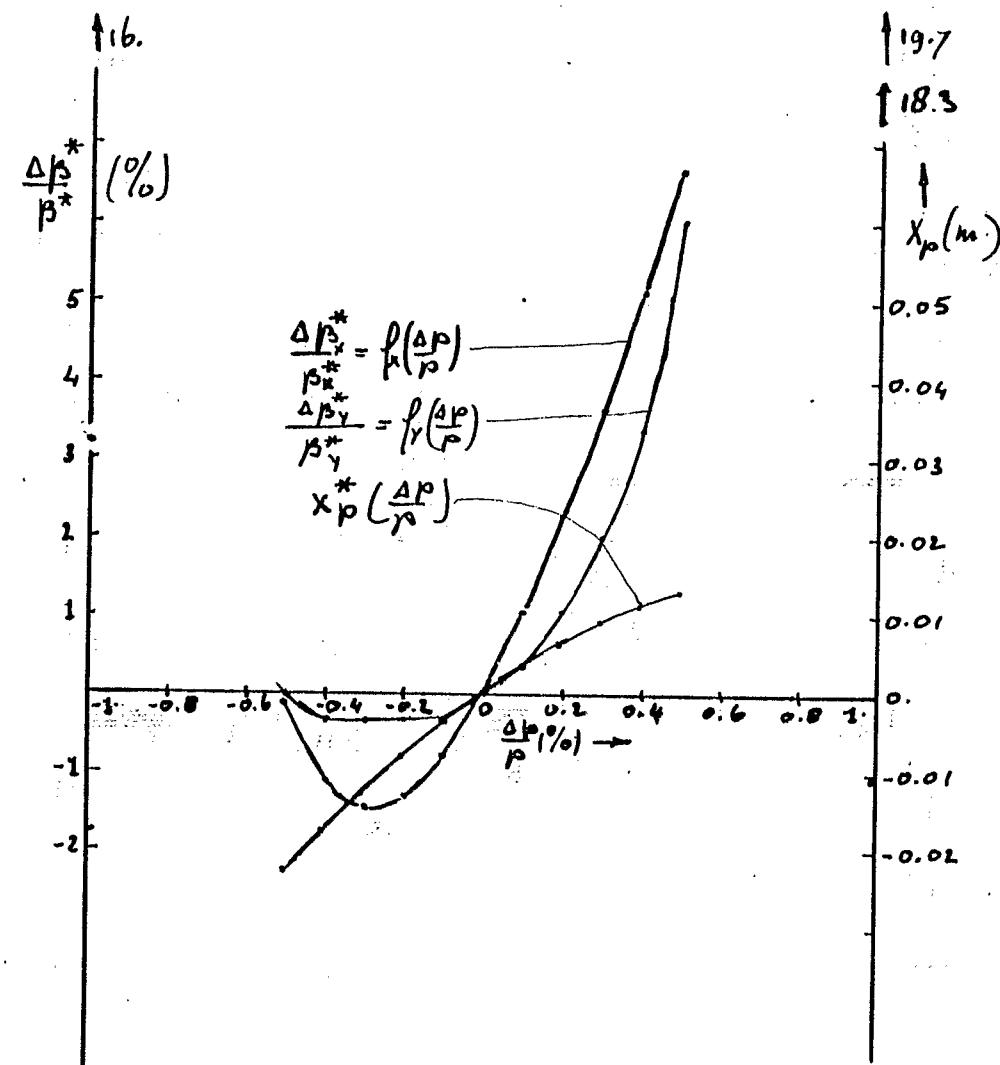
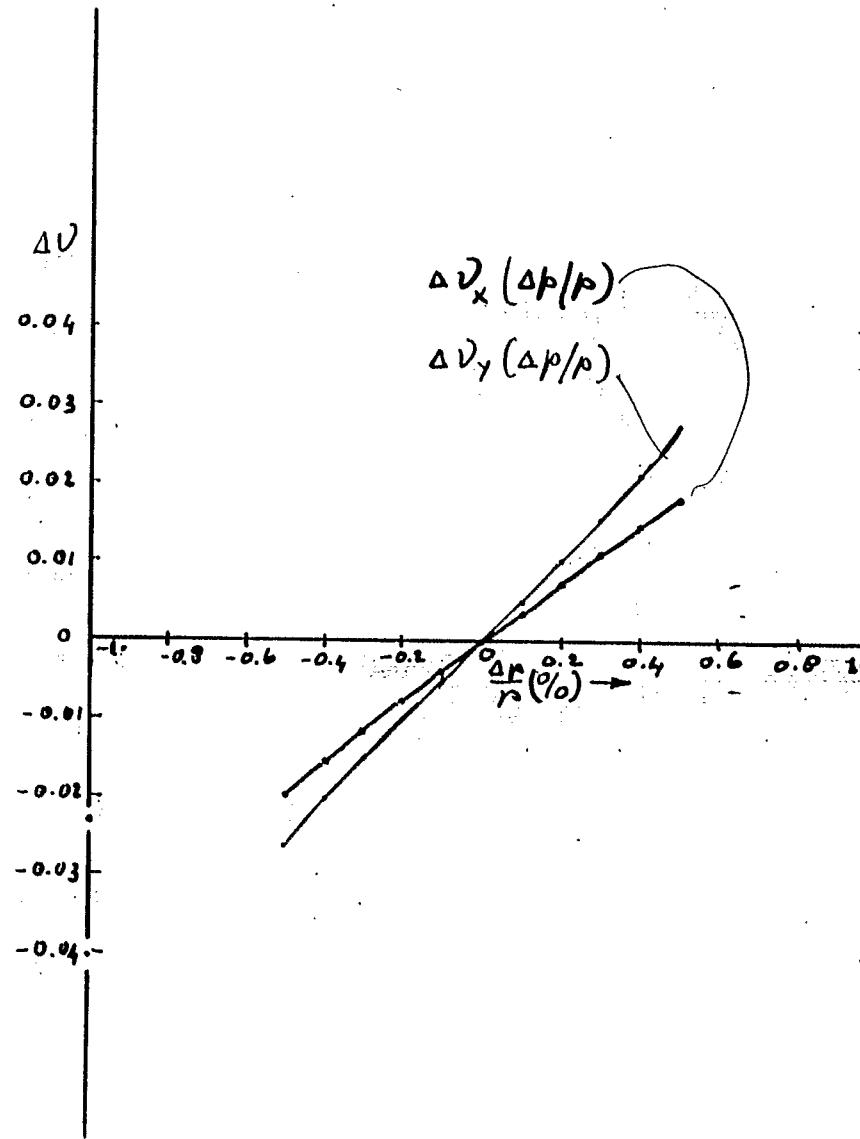
Center at 590.515m

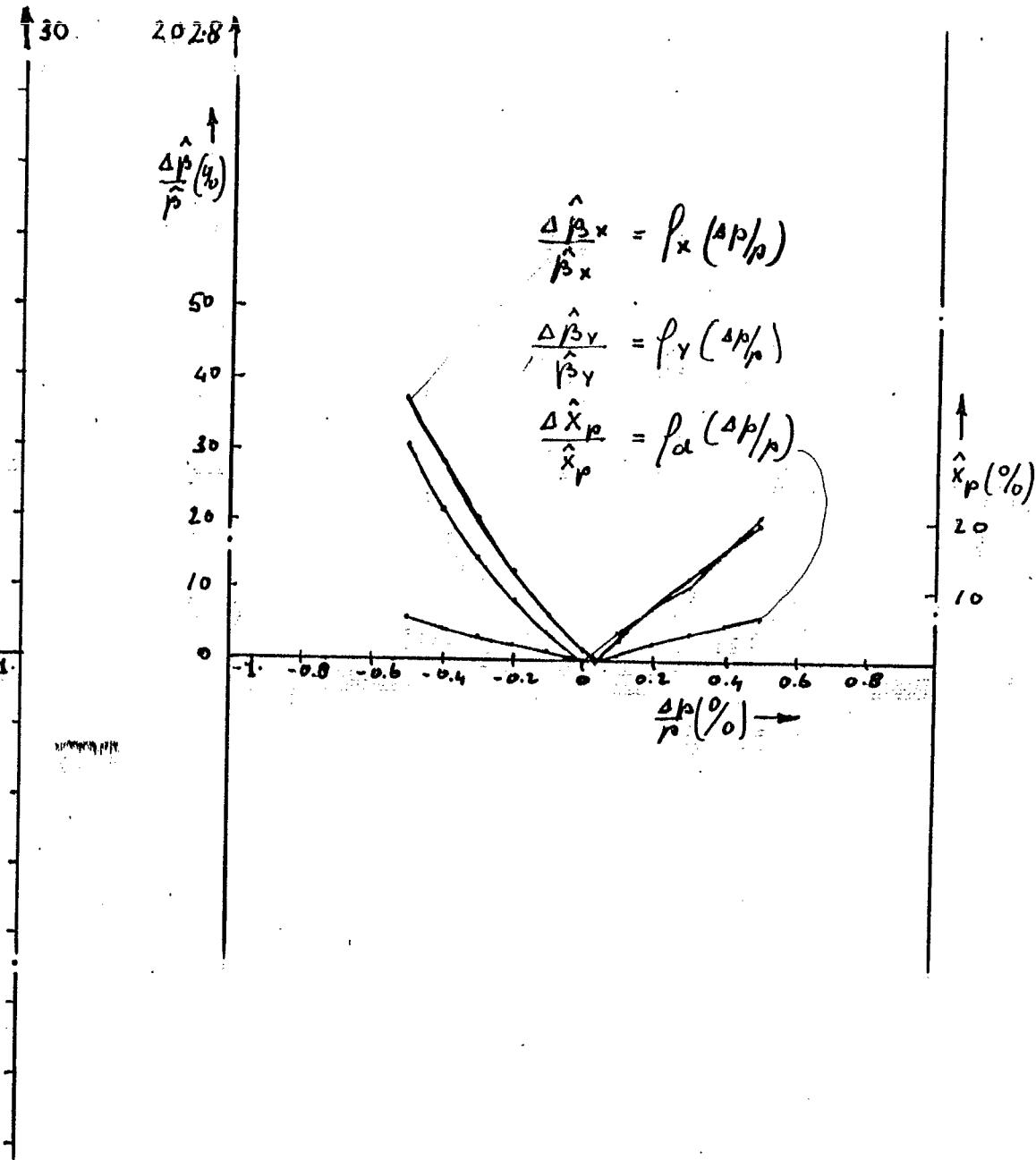
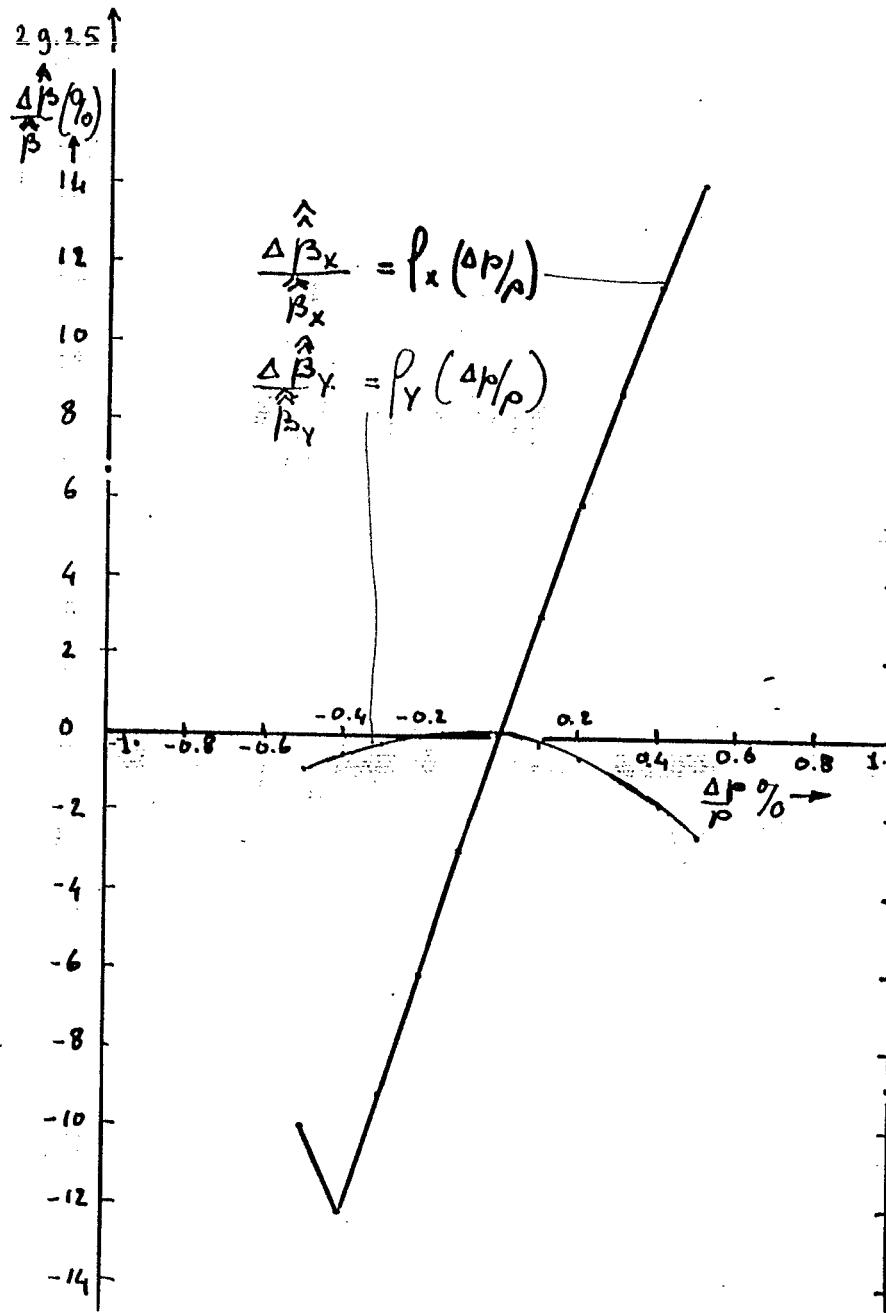


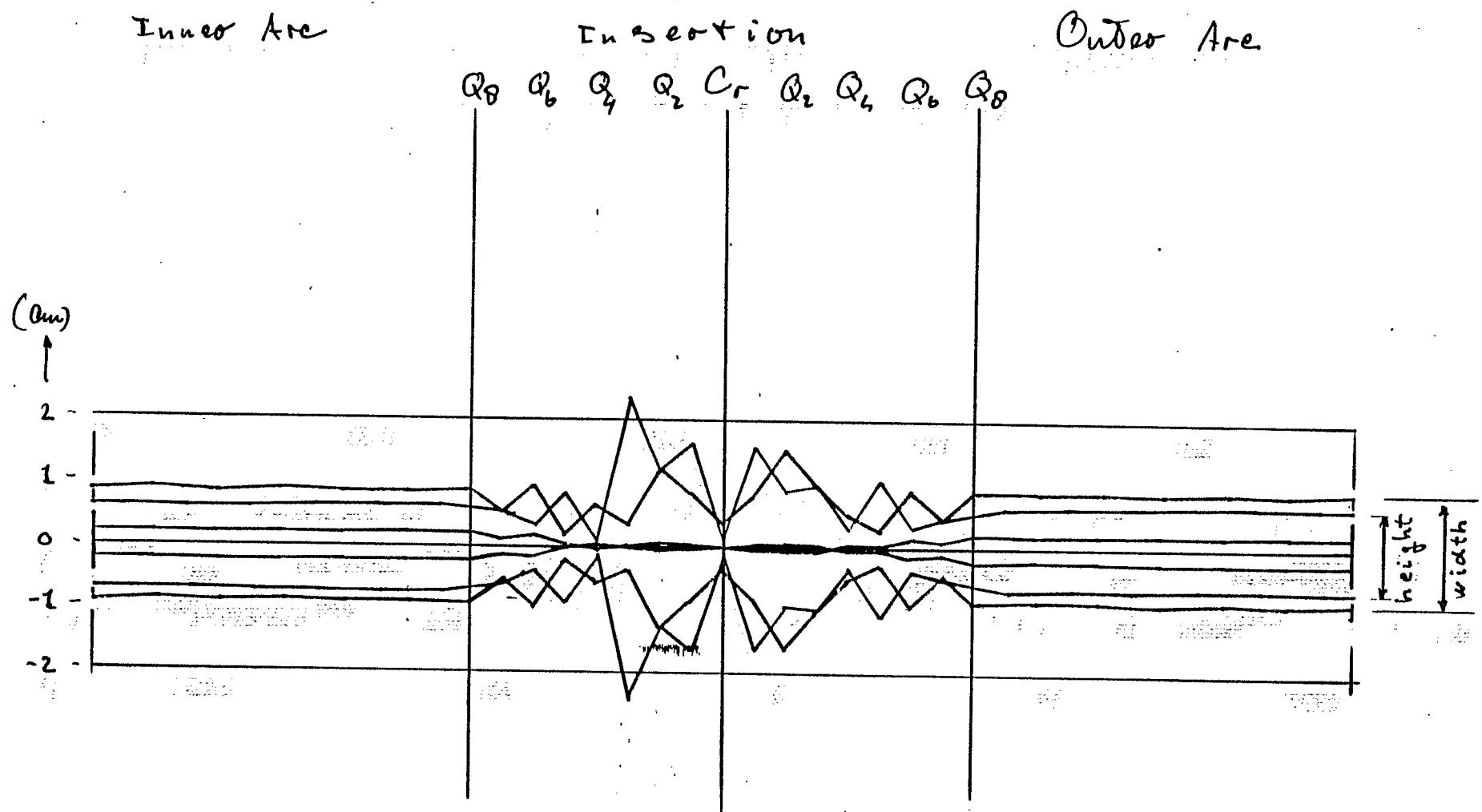
↑
(m)







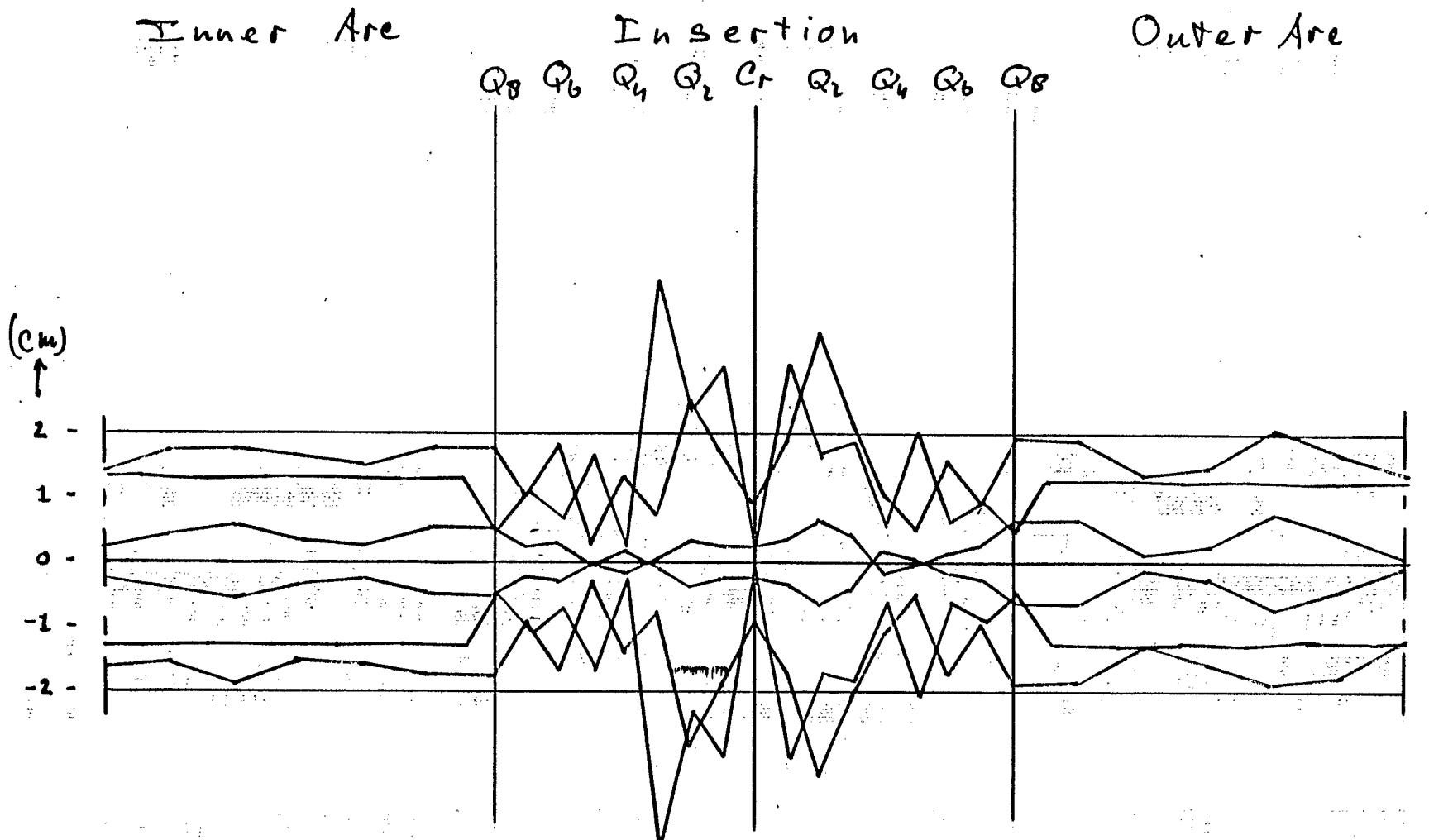




Beam dimensions at injection
 $r = 12$

$$\Sigma = 10 \times 10^{-6} \text{ rad-m (2.55)}$$

$$\frac{\Delta p}{p} = \pm 1.62 \times 10^{-3}$$



Beam dimensions after 2 hrs
at $\gamma = 12$

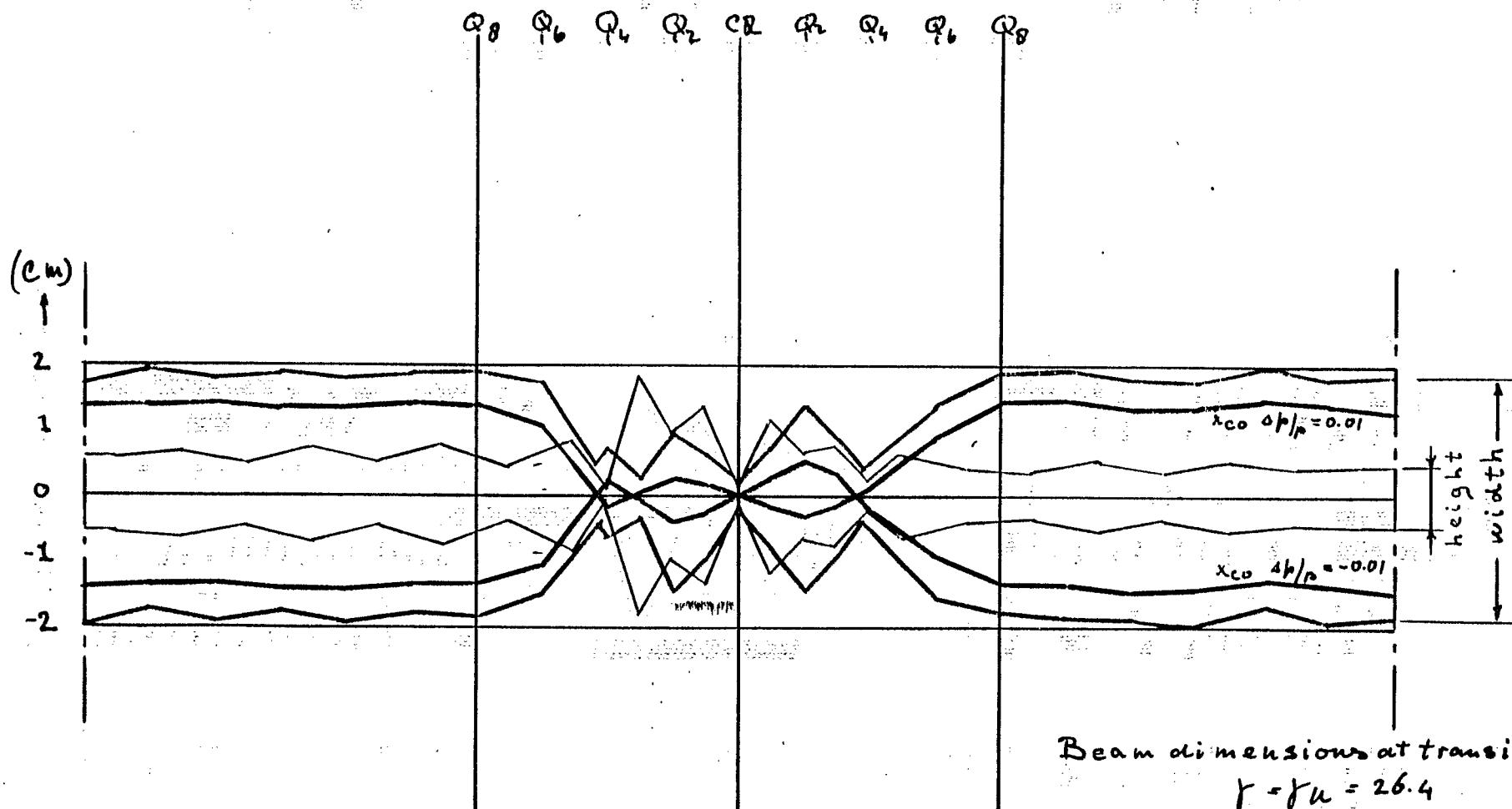
$$z = 34.5 \times 10^{-6} \text{ rad-m (2.5T)}$$

$$\frac{\Delta p}{p} = \pm 3 \times 10^{-3}$$

Inner Arc

Insertion

Outer Arc



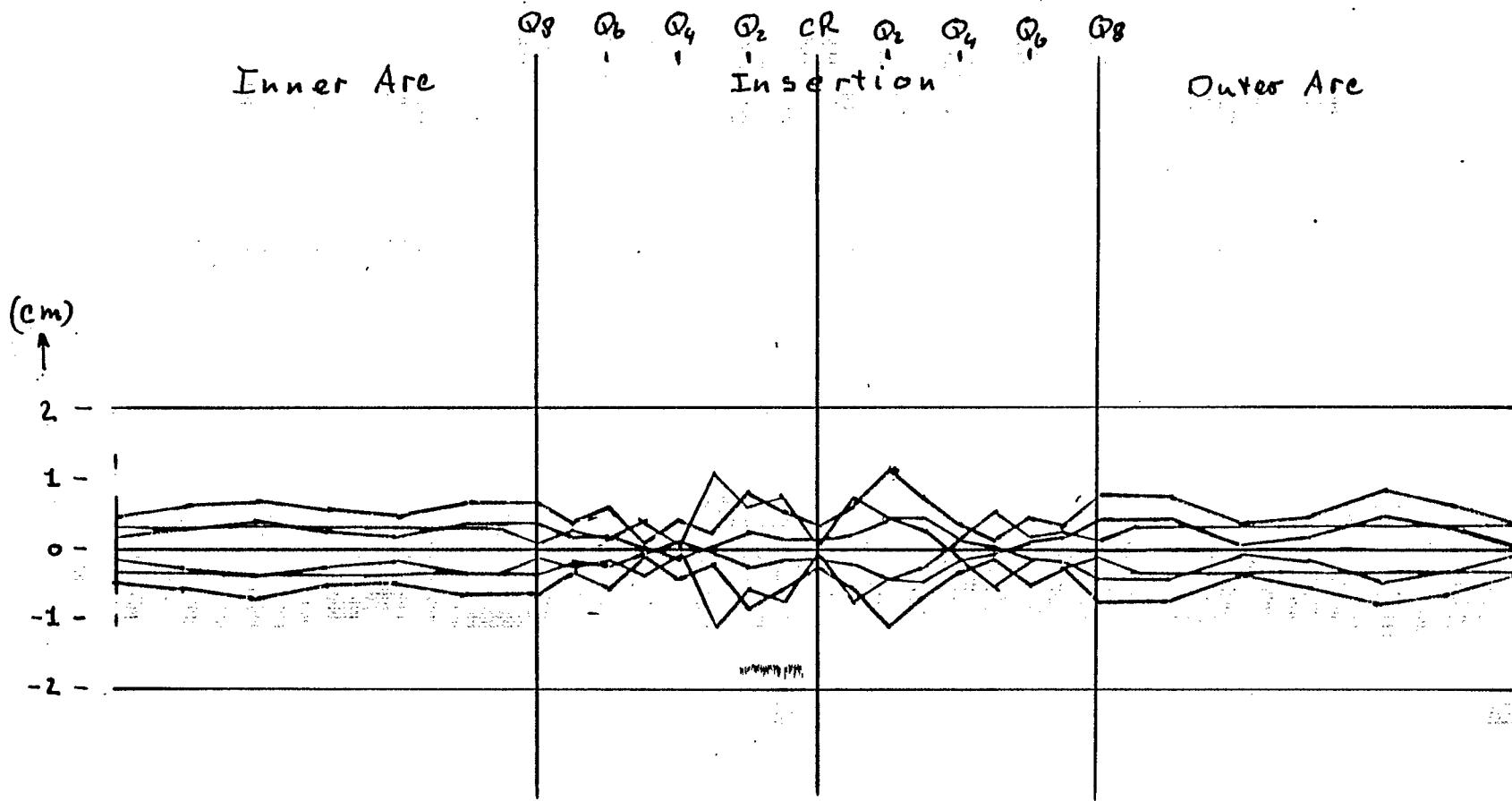
Beam dimensions at transition

$$\gamma = \gamma u = 26.4$$

$$\epsilon = 10 \times 10^{-6} \text{ rad-m (2.56)}$$

$$\Delta p/p = \pm 0.01$$

03/06/84 16.34.47 JEL



Beam dimensions after 2 hrs
at $\gamma = 100$

$$\epsilon = 18.4 \times 10^{-6} \text{ rad-m} (2.5\sigma)$$

$$\frac{\Delta p}{p_0} = \pm 2 \times 10^{-3}$$